

COMBUSTION SOLUTIONS FOR THE FUTURE



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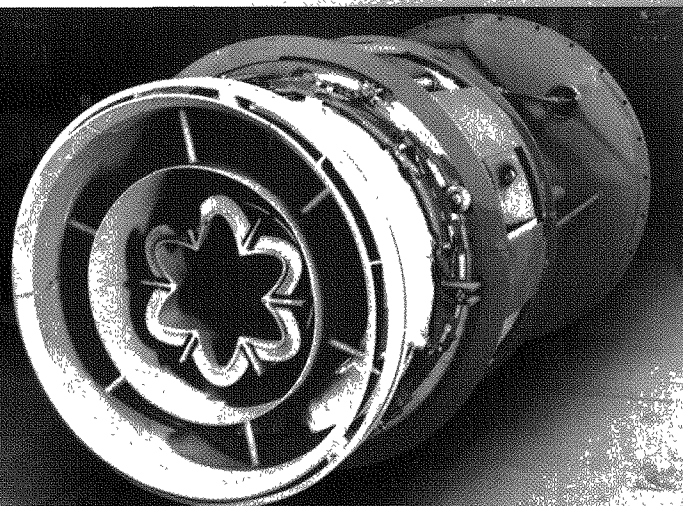
**Advanced Burner Technologies (ABT)** is a full service company supplying modern combustion systems to the electric power utility and industrial sectors. Complete engineering, design, field service and project management capability, with an experienced staff, enable us to supply well-designed, quality equipment and services.

Our goal has been to develop long-term, mutually productive relationships with our customers by supplying them with reliable, efficient and cost-effective methods of controlling NO<sub>x</sub> and solving fuel supply and distribution problems that limit the effectiveness of combustion equipment.

**ABT utilizes a systems approach to the development of combustion-related products: from the pulverizer to the furnace, all components contribute to the final thermal and emissions performance of the boiler. ABT's approach considers the primary air system, pulverizer performance, fuel line balancing, secondary air duct/wind-box flow conditions and the boiler's configuration as a total integrated system.**

Understanding the importance of long-term reliability of combustion equipment, to maximize the time between boiler outages, is inherent in our design. All components exposed to the furnace environment are high temperature stainless steel: wherever applicable ABT uses castings, as opposed to plate fabrications, in order to minimize stresses, warpage and thermally-induced corrosion. Components in the coal path are protected with appropriate and effective erosion-resistant materials for long maintenance-free life.

Computational Fluid Dynamic models are used for thermal and flow analysis of burners, overfire air systems, boilers and associated ductwork. Where appropriate we also utilize physical two-phase flow modeling to optimize the performance of burners and balancing systems for pulverized coal, biomass and other solid fuels.



Combustion in multiple burner systems cannot be optimized without minimizing the air and fuel imbalances between burners. ABT has developed novel, passive technologies that do not require on-line measurements and computer support to balance fuel lines. The balancing is done aerodynamically through the design of the equipment.

**THE MORE ELEGANT THE SOLUTION,  
THE SIMPLER THE DESIGN.**





## THE OPTI-FLOW™ SOFA SYSTEM

ABT's SOFA system utilizes aerodynamically staged ports, similar to those ports ABT uses on wall-fired boilers. The non-circular two-stage port includes a manually tiltable central section. However, yaw or transverse flow is accomplished entirely aerodynamically, with no moving parts to produce this effect.

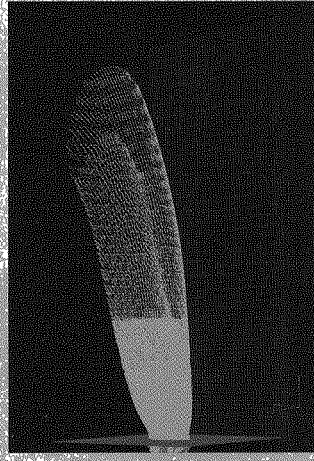
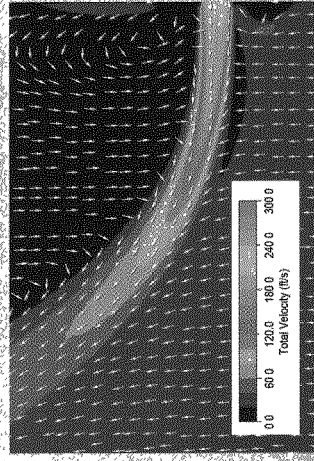
### THE THREE MOVING PARTS IN THE OPTI-FLOW-T SOFA PORT ARE:

- Sleeve damper, manually or remote electric control, for flow control into the port.
- Proportioning damper: manual control to optimize the split of air flow between the inner, tiltable section and the outer yaw section.
- Manual tiltable inner air zone to direct a portion of the OFA flow higher or lower in the furnace.

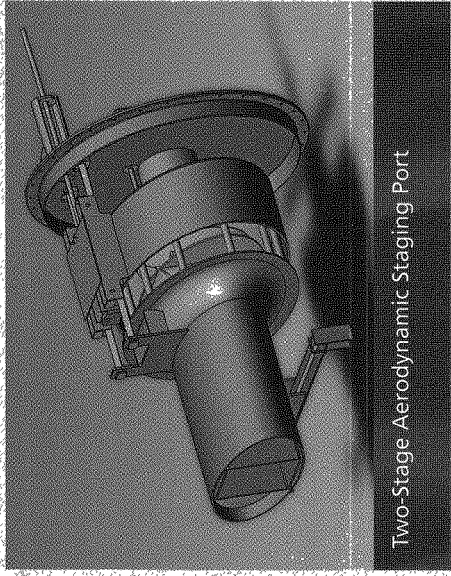
### THE OPTI-FLOW™-T LOW NO<sub>x</sub> COMBUSTION SYSTEM CONTROLS NO<sub>x</sub> WITH A THREE-STAGE PROCESS:

- Near burner zone using the Opti-Flow™ Low NO<sub>x</sub> nozzle
- Far burner zone via the long residence time inherent in the tangential combustion system
- An advanced SOFA system and side-fired air to permit effective staging of the combustion zone

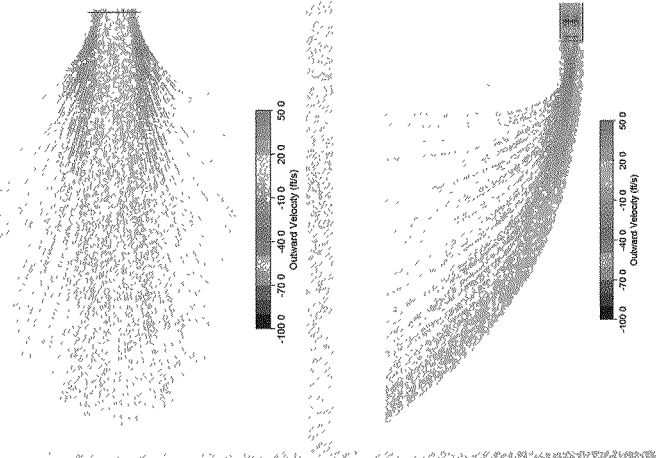
**EXCELLENT PENETRATION INTO FURNACE AND RECIRCULATION ALONG FURNACE WALL PROVIDE INTIMATE MIXING FOR BURNOUT OF CO AND UBC**



The Opti-flow-T SOFA ports are located in the walls, not the corners, so that maximum mixing occurs between the up-rising, rotating furnace gases and the transversely injected SOFA flow. Port wall openings are made of boiler tubes with no refractory, for long life and maintenance-free operation.



Two-Stage Aerodynamic Staging Port

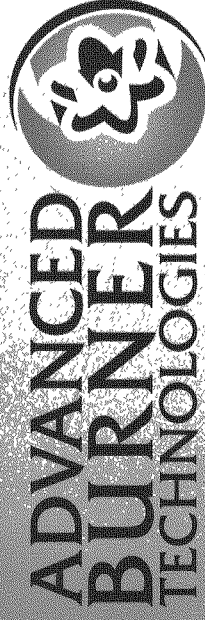


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## TANGENTIAL - FIRED SYSTEM

# Opti-Flow™ Low NO<sub>x</sub> Combustion

TANGENTIAL-FIRED BURNERS AND OVERFIRE AIR SYSTEMS





## OPTI-FLOW™ -T LOW NO<sub>x</sub> SYSTEM

Conventional tangential-fired low NO<sub>x</sub> systems rely on using large quantities of overfire air, as the primary NO<sub>x</sub> control, to attain significant NO<sub>x</sub> reductions from the standard T-fired combustion system.

**ABT takes a different tack.** Use low NO<sub>x</sub> burner principles to reduce the NO<sub>x</sub> where it is formed: **at the burner.** Then use OFA the way it is used on wall-fired boilers we modify: as a supplemental NO<sub>x</sub> control rather than the primary NO<sub>x</sub> control.

### ABT's basic principles of T-fired NO<sub>x</sub> control:

#### EFFECTIVE LOW NO<sub>x</sub> FUEL INJECTOR:

ABT utilizes the advanced Opti-Flow™ fuel injector that is also effectively used on wall-fired boilers to:

- Achieve early NO<sub>x</sub> control of volatile fuel nitrogen by producing effective low NO<sub>x</sub> burner flame conditions.
- Control thermal NO<sub>x</sub> by producing an internally staged flame that prevents formation of excessive NO<sub>x</sub> formed from atmospheric nitrogen.
- Minimize the amount of overfire air, thereby not deep-staging the burner zone.

**SIDE-FIRE AIR FOR SLAG, CORROSION AND CO CONTROL:** ABT incorporates a side-fired air system in the burner array to blanket the walls with an oxidizing atmosphere. Along with this system ABT incorporates a close-coupled side-fired OFA system to blanket the walls between the top burner level and the SOFA level with an oxidizing atmosphere for CO, UBC and slag/corrosion control.

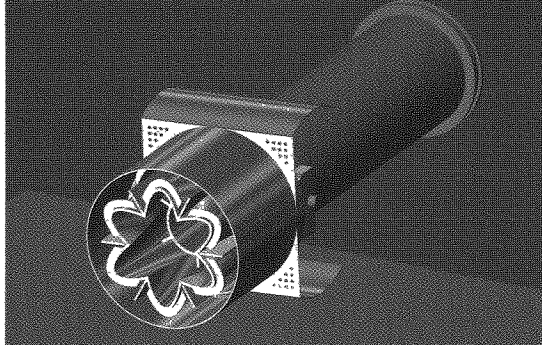
**SEPARATE OVERFIRE AIR(SOFA):** A set of OFA ports is located above the top burner level and sufficiently high in the furnace to maximize NO<sub>x</sub> reduction while minimizing CO and unburned carbon. This system takes advantage of the long residence time available in the combustion zone of the T-fired flame.

**SYSTEM BALANCE:** In order to attain minimum NO<sub>x</sub> simultaneously with minimum CO and UBC it is necessary to balance the flame pattern to eliminate zones of very high coal flow (low stoichiometry) that generate high CO and UBC, and zones of very low coal flow (high stoichiometry, high excess air) that generate high NO<sub>x</sub>. Balancing the system also eliminates severe gas temperature imbalances entering the super-heater.

The Opti-flow-T low NO<sub>x</sub> fuel injector eliminates coal roping by including fuel distributors in the inlet elbow to attain good fuel distribution leaving the coal nozzle.

A tilting segmented Opti-flow coal nozzle incorporates an integral secondary air flow divider and flow shield to produce the desired flame conditions over the desired tilt range.

#### OPTI-FLOW-T FUEL INJECTOR



Secondary air nozzles are sized appropriately for the quantity of secondary air flow, taking into account the SOFA flow.

The Opti-flow-T low NO<sub>x</sub> fuel injector and secondary air nozzle aerodynamics yield the desirable flame conditions for minimum NO<sub>x</sub>, CO and unburned carbon.

All components facing the fire are either cast or fabricated high temperature stainless steel.

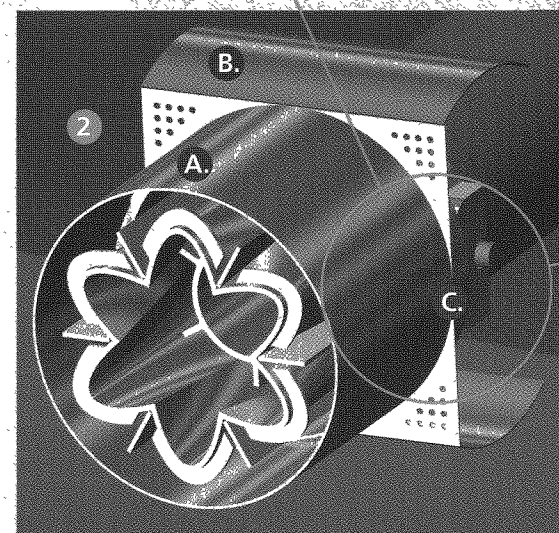
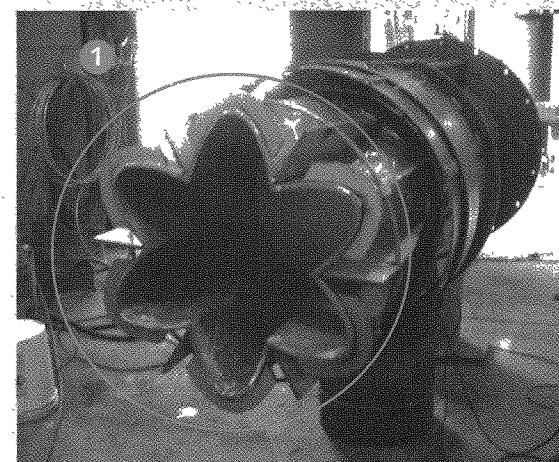
**THE OPTI-FLOW-T LOW NO<sub>x</sub> SYSTEM: MODERN, EFFECTIVE NO<sub>x</sub> CONTROL FOR TANGENTIAL-FIRED BOILERS.**

## THE OPTI-FLOW™ -T LOW NO<sub>x</sub> BURNER SYSTEM

BASED UPON THE WALL-FIRED OPTI-FLOW™ FUEL INJECTOR **1** THE TILTABLE OPTI-FLOW™-T FUEL INJECTOR **2** INCLUDES:

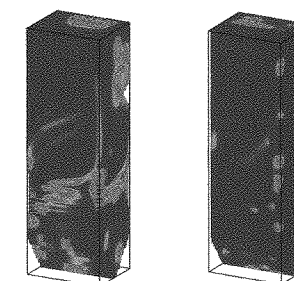
- Secondary airflow divider to assure cohesive secondary airflow around the coal nozzle. Thus assuring optimal aerodynamic conditions for flame stability and low NO<sub>x</sub> combustion.
- Secondary airflow shield to prevent passage of uncontrolled air into the furnace and bypass the low NO<sub>x</sub> nozzle.
- A novel tilt mechanism and nozzle seal arrangement to prevent coal blow-back and assure long-term reliable operation.

THE FUEL INJECTORS **2** ARE INCORPORATED INTO THE OPTI-FLOW™-T LOW NO<sub>x</sub> BURNER T-FIRED SYSTEM **3** ALONG WITH OPTI-FLOW™ SECONDARY AIR NOZZLES.



## SLAGGING AND CORROSION CONTROL

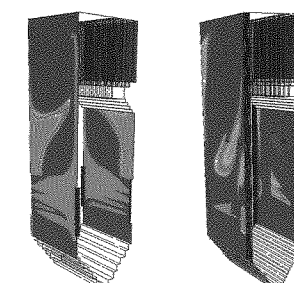
### Total Particle Mass Deposition Rate



Previous Baseline | ABT Final Case

ABT's Design eliminates particulate impact on furnace walls. Slagging and Corrosion from molten ash are reduced.

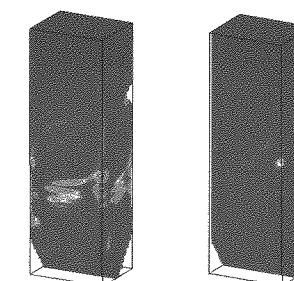
### CO Concentration



Previous Baseline | ABT Final Case

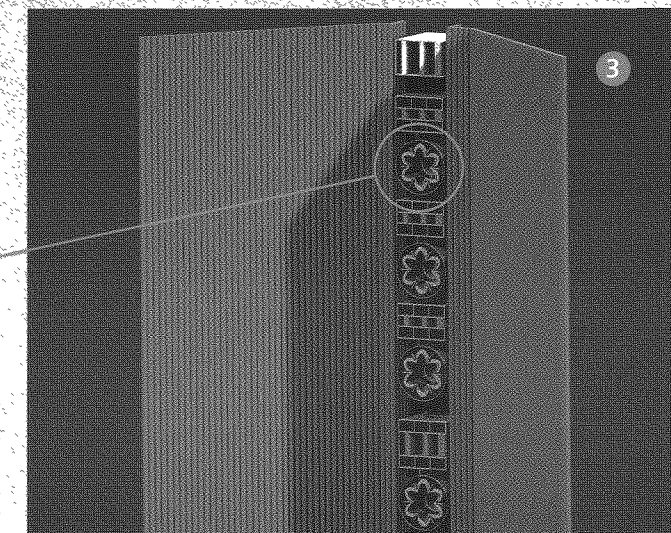
ABT's design eliminates unburned carbon long furnace walls and localized reducing conditions, inhibiting corrosion and slagging. ABT's LNB and SOFA reduce NO<sub>x</sub> significantly.

### Unburned Particle Mass Deposition Rate

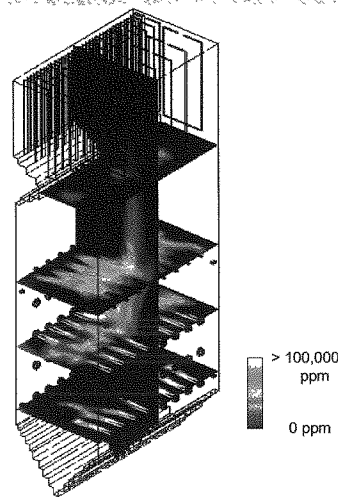


Previous Baseline | ABT Final Case

	ABT OFA Final Case
NO <sub>x</sub> (lb/MMBtu)	40% Reduction
Carbon in Fly Ash	75% Reduction
Temperature at Horizontal Nose Plane (°F)	same
CO at Horizontal Nose Plane	5% Increase



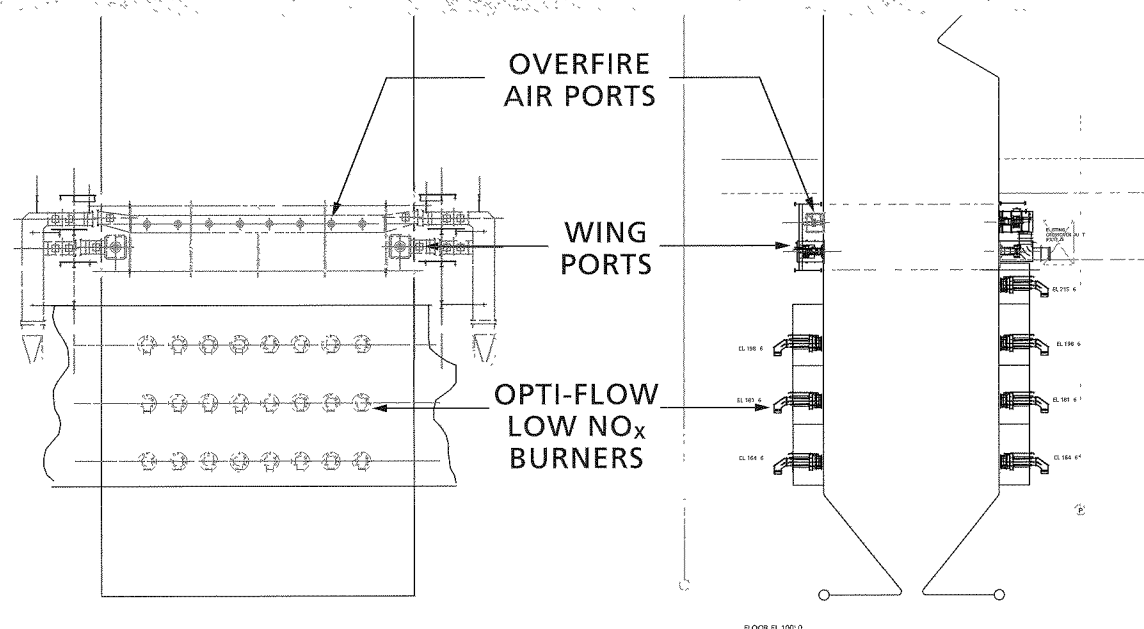




**Figure 6**  
CFD Study of 700MW Lignite-fired Boiler: CO Analysis

Overfire air effectiveness is limited by the amount of CO and Unburned Carbon that reach the furnace exit and, when excessive amounts of OFA flow are used on coal-fired boilers, by lower furnace slag and corrosion. The effectiveness of ABT's system in controlling CO is illustrated by Figure 6, which is a CFD study of a 700 MW boiler.

The CFD study predicts negligible CO at the furnace exit. Actual results are 25-75ppm at a NO<sub>x</sub> level of about 0.15 lb/10<sup>6</sup> Btu.



**Figure 7**  
Air Staging System for 700MW Lignite-fired Boiler

Figure 7 illustrates the air staging system design arrangement for a 700MW, 56 burner Lignite-fired boiler (Fig. 6) that attains NO<sub>x</sub> of 0.15 with CO typically below 100ppm. One OFA port is located, in a conventional manner, over each burner column. A novel feature of the ABT staging system is the use of "Wing Ports" located vertically between the OFA elevation and top burner elevation and horizontally between the side (or wing) burners and the sidewalls. The

Wing Ports inject air at a lower elevation than the OFA ports in order to maximize the residence time between the injection point and the furnace exit to achieve maximum CO burnout. In general, wall-fired boilers generate significant CO concentrations along the sidewalls; even when burners are well balanced. Locating a set of staging ports closer to the burner zone than the OFA ports maximizes both the temperature and time for CO burnout.

OPTI-FLOW™ OVERFIRE AIR SYSTEMS

# Opti-Flow™ Overfire Air Systems

FOR BOILERS FIRING: OIL GAS COAL AND BIOMASS

**ADVANCED  
BURNER  
TECHNOLOGIES**

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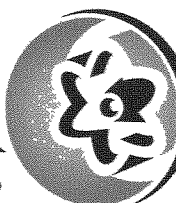
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## OPTI-FLOW™ OVERFIRE AIR SYSTEMS

### FOR BOILERS FIRING:

OIL • GAS • COAL (PULVERIZED or CYCLONE)  
AND BIOMASS

- Control CO and Unburned Carbon with ABT's Aerodynamically-staged Overfire Air Port System
- Dual staged ports with only two moving parts.
- Single staged ports with only one moving part.
- Optimal mixing of Overfire Air with combustion gases is accomplished using aerodynamics, for penetration with excellent transverse mixing, not complicated registers or adjustable vanes.

When ABT's OFA system is used in conjunction with the Opti-Flow low NO<sub>x</sub> burner, optimum combined burner/OFA performance can be obtained:

**NO<sub>x</sub> LEVELS BELOW 0.3 ON BITUMINOUS COAL ARE ATTAINABLE; AND AS LOW AS 0.15 FIRING LIGNITE OR PRB.**

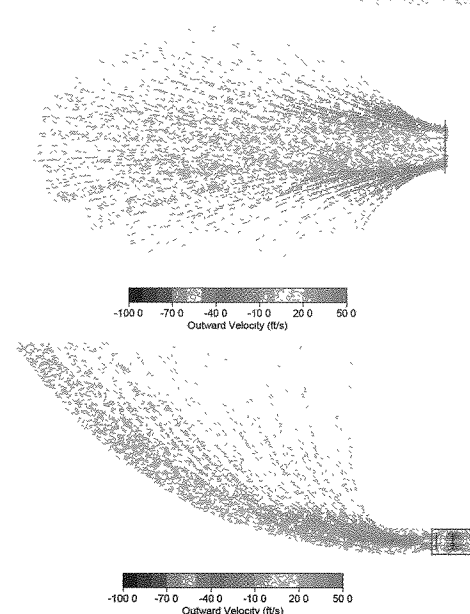
### ABT'S OFA SYSTEM OFFERS THE FOLLOWING ADVANTAGES:

1. Water-cooled throats are used thereby eliminating problematic refractory.
2. Booster fan is not required.
3. Installation is accomplished by either utilizing the existing OFA wind-box or by installing a new OFA wind-box above the burner windbox on boilers without an existing OFA wind-box.
4. Probability of lower furnace slag formation and corrosion is minimized since burners are not operated deep staged thus keeping the furnace sidewall atmosphere oxidizing-not reducing.

**ABT UTILIZES HIGH TEMPERATURE, HIGH QUALITY STAINLESS CASTINGS FOR ALL COMPONENTS FACING THE FIRE. THE RESULT IS YEARS OF RELIABLE, MAINTENANCE-FREE OPERATION.**

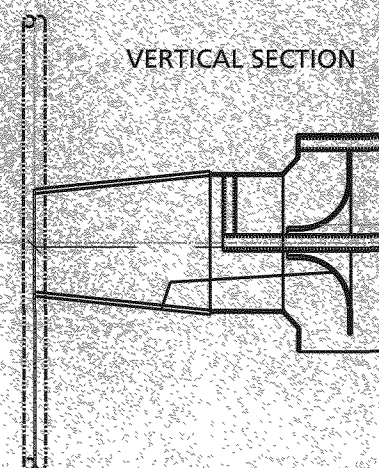
Either a single or two-stage OFA port is used, depending on the specific furnace conditions. The single stage port generates a mixing pattern that is both longitudinal and transverse across the furnace plan. However, with this design the pattern is fixed and varies only with flow. In order to adjust the relative penetration and transverse mixing patterns the two-stage port is used. The mixing pattern is modified by varying the ratio of air between the inner and outer zones of the port.

Extensive modeling was performed to develop and optimize the unique, non-circular overfire air port utilized in ABT's OFA system. This port is designed to penetrate the depth of the furnace, while providing transverse coverage to mix with, and complete the combustion of, up-rising furnace gas. Figure 1 illustrates the CFD results of ABT's two-stage OFA port. The central section creates axial penetration while the outer zones produce intense horizontal recirculation flows that enhance mixing between the OFA flow and furnace gases rising between adjacent ports.

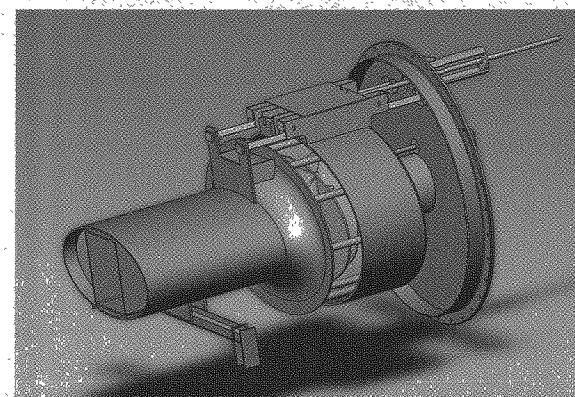


**Figure 1**  
CFD Study of Two-Stage Opti-Flow OFA Port

Figure 2 illustrates the single stage port design. The inlet (adjustable bell-mouth) is a low loss design that acts as both a damper for flow control and an air director. All components exposed to furnace radiation are stainless steel; the nozzle being a casting.



**Figure 2**  
Single Stage Aerodynamic Staging Port



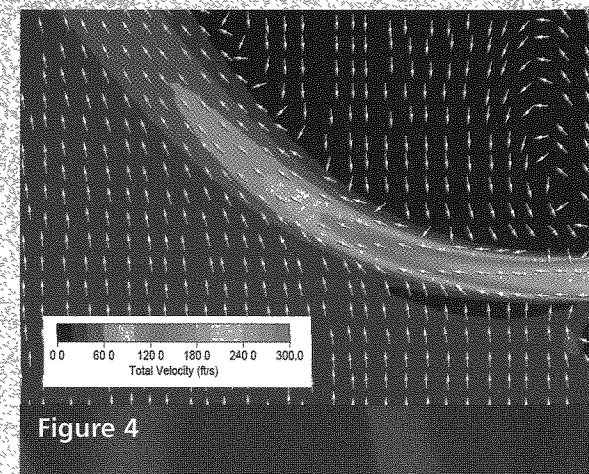
**Figure 3**  
Two-Stage Aerodynamic Staging Port

**Opti-Flow Aerodynamic OFA:** Produces excellent penetration into furnace and transverse mixing across the furnace plan area to provide intimate mixing between the OFA flow and rising furnace gases for excellent burnout of CO and UBC.

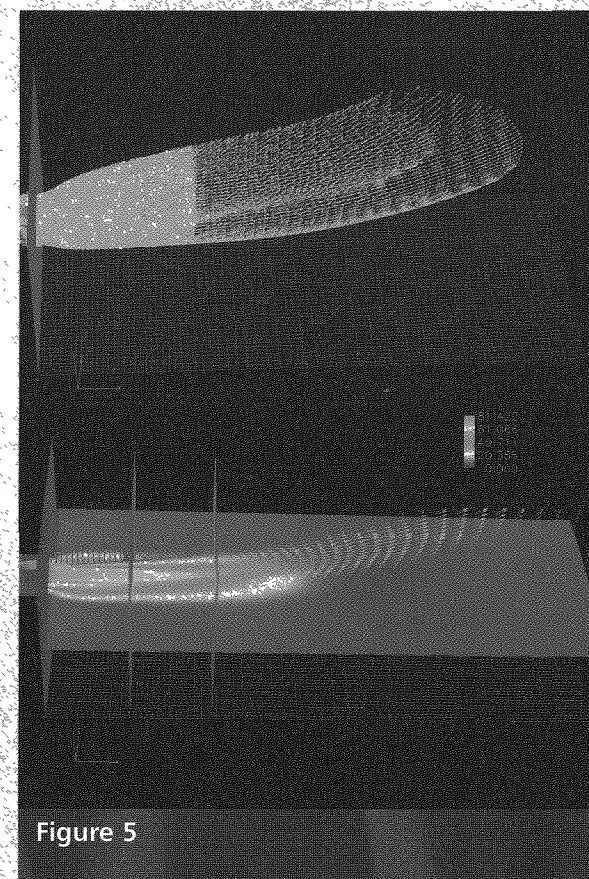
Figure 3 illustrates the two-stage port design. In this case the bell-mouth divides the flow between the inner and outer passageways; total flow control is via a sleeve damper when all ports are supplied by a common windbox, or via a separate damper for any port that may be within an individual windbox.

### OPTI-FLOW™ SOFA

Excellent Penetration into furnace and recirculation along furnace wall provide intimate mixing for burnout of CO and UBC.



**Figure 4**



**Figure 5**



# Burner Modules

OPTI-FLOW™ LOW NO<sub>x</sub> BURNER



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## THE OPTI-FLOW™ LOW NO<sub>x</sub> BURNER

Advanced Burner Technologies' Opti-Flow low NO<sub>x</sub> burner began commercial operation in 1997 and has been installed on numerous utility steam generators ranging in capacity from 70MW to over 700MW. Projects undertaken:

- Upgrade boilers from the OEM-supplied LNB's to ABT's Opti-Flow™ low NO<sub>x</sub> burner by substituting the Opti-Flow fuel injector design for the OEM design.
- Completely replace the original low NO<sub>x</sub> burners with the Opti-Flow design.

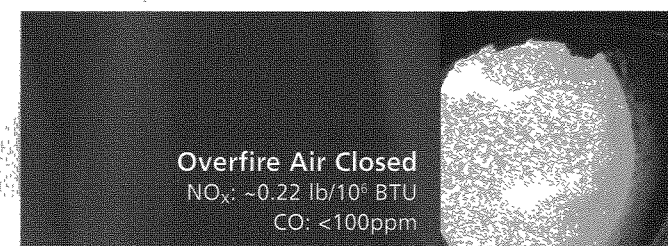
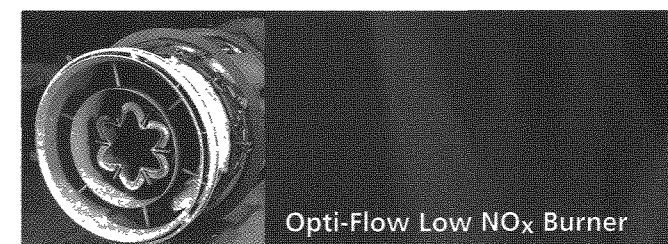
Fuels experience ranges from lignite to PRB to eastern high sulfur bituminous coals.

### Results:

NO<sub>x</sub> reductions, as compared to the burners replaced, range from 30 to over 40%, depending on the fuel and boiler specifics.

NO<sub>x</sub> levels below 0.3lb/10<sup>6</sup> Btu are attained on bituminous-coal fired boilers, and in the "mid-teens" range with lignite and PRB, when overfire air is used in conjunction with the Opti-Flow low NO<sub>x</sub> burner.

### ABT LOW NO<sub>x</sub> BURNERS AND OVERFIRE AIR INSTALLED ON A 700 MW LIGNITE-FIRED BOILER



ABT's combustion NO<sub>x</sub> control philosophy can be summarized as follows:

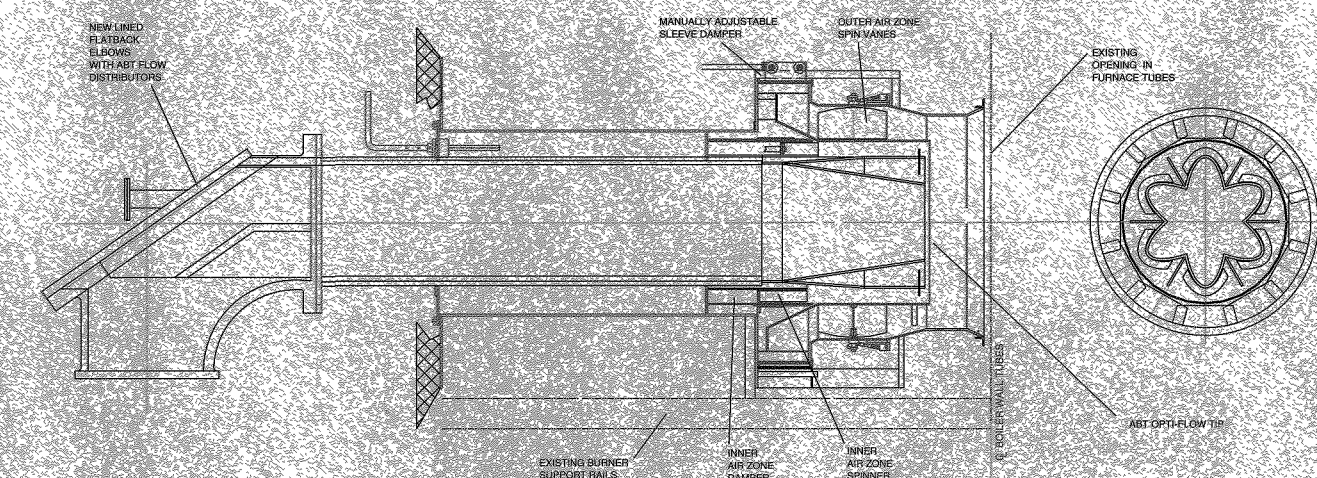
- Utilize a low NO<sub>x</sub> burner that minimizes NO<sub>x</sub> without compromising boiler performance.
- Develop a stable flame inside the burner throat, regardless of fuel type.
- The primary NO<sub>x</sub> control element is a stable, highly effective low NO<sub>x</sub> fuel injector.
- Overfire air can be used, where necessary, as a secondary NO<sub>x</sub> control element while maintaining burner stoichiometry(S) > 1. However, where furnace and fuel conditions permit, the burner can be operated sub-stoichiometrically to further reduce NO<sub>x</sub> generation.

Burner line fuel/air balance, coal fineness, wind-box air distribution, etc, all affect NO<sub>x</sub> reduction by detracting from the optimum fuel/air ratio at the burner. Optimizing these variables allows the low NO<sub>x</sub> burner/OFA system to operate as intended. ABT also supplies the necessary equipment to address these problems.

The following is a summation of the salient features and benefits provided by the Opti-Flow low NO<sub>x</sub> burner:

- The ABT fuel injector produces nearly uniform fuel distribution around the burner nozzle's circumference, which provides significant aid in simultaneously attaining minimum NO<sub>x</sub> and UBC.
- A highly stable, very bright flame is produced that is also adjustable so that it can be used in either tight, high temperature pre-NSPS furnaces or larger, low temperature NSPS units without compromising furnace performance.

## TYPICAL OPTI-FLOW™ BURNER MODULE



### Fuel Injector Sub-assembly:

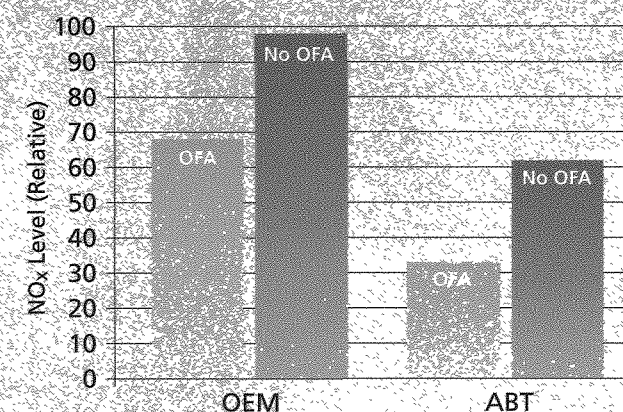
- Flatback with integral flow enhancing insert, for installation into existing 90° elbows, generates an approximately uniform fuel distribution at the nozzle. New elbows can be supplied as needed.
- Opti-Flow low NO<sub>x</sub> segmented nozzle with external stabilizers; there are no internal obstructions to the free passage of coal. Consequently, this design has a long life-time due to its minimum stress and minimum erosion design.

### Opti-Flow™ Dual Register sub-assembly:

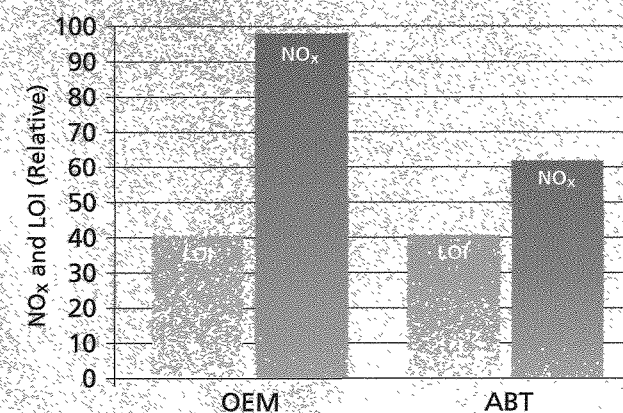
- Sleeve Damper for secondary air flow control. Air flow to each burner is controlled by axially adjusting the sleeve's position relative to the register opening. The registers' sleeve dampers are locally manually adjustable on those boilers that have fully horizontally compartmented wind-boxes, with secondary air flow control by side damper.
- Inner Air Flow Distributor: adjustable to vary the ratio of air flow between the inner secondary air zone and the outer zone. This is a manual adjustment made during burner optimization.
- Outer Passageway Swirl Vanes: Manually adjustable from the burner front to optimize the secondary air swirl in the outer zone.
- Inner Passageway Fixed Swirl Vanes: provide inner secondary air zone turbulence to aid in flame stabilization.
- Side-fired igniters are mounted external to the coal nozzle in the secondary air path through the outer register.

## TYPICAL RESULTS FROM SEVERAL BITUMINOUS COAL-FIRED BOILERS

Comparing relative NO<sub>x</sub> levels between the OEM low NO<sub>x</sub> burners and ABT's upgrade, NO<sub>x</sub> is reduced over 30% without or with overfire air in service.



Comparing NO<sub>x</sub> and LOI levels attained with the ABT burners: LOI remains in the same range as before although NO<sub>x</sub> is decreased by over 30%.



A typical bituminous coal flame indicates the excellent stability attained by the Opti-Flow low NO<sub>x</sub> burner.



# Fuel Injectors

FUEL INJECTORS

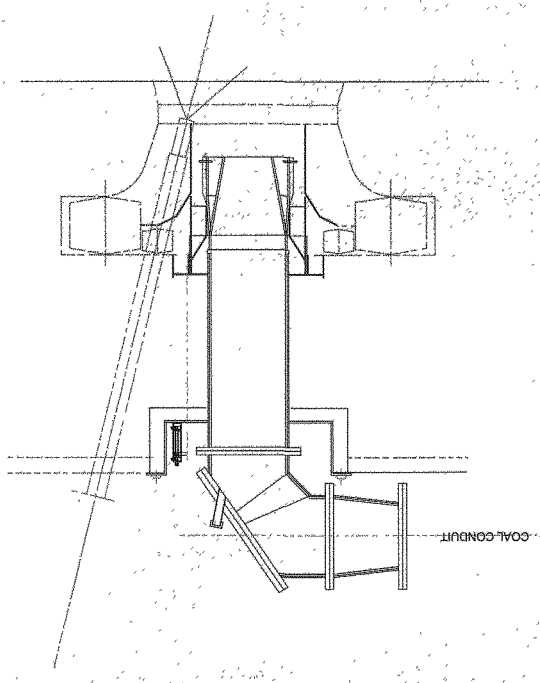


The OPTI-FLOW™ Fuel Distribution System is located in the elbow and is installed without removing the fuel injector. Other fuel distributors, which are located downstream of the elbow, cause coal "ropes" to impact on the coal nozzle and, thereby, reduce its usable life.

The OPTI-FLOW™ system eliminates coal ropes and produces a nearly uniform fuel/air mix with axial flow downstream of the elbow. Therefore, the only erosion-prone areas will be located within the elbow. These areas are lined with erosion resistant materials and are easily replaceable when necessary.

Figure 6 is a photograph of an OPTI-FLOW™ fuel injector in use on a 56 burner 700MW lignite-fired boiler. The open nature of the fuel injector is clearly shown. The fuel distribution system is contained in the elbow.

As shown in Figure 7, it is also feasible to convert a scroll-based burner into the ABT elbow design while maintaining the same coal pipe centerline distance from the windbox wall.

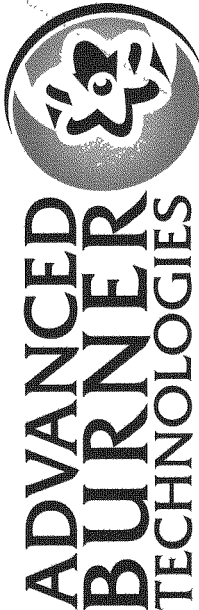


**Figure 7**  
Elbow Conversion of Scroll-type Low NO<sub>x</sub> Burner

**OPTI-FLOW™ FUEL INJECTORS:**  
**STATE OF THE ART UPGRADES FOR**  
**WALL AND TANGENTIAL-FIRED BOILERS.**



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**OPTI-FLOW™ LOW NO<sub>x</sub> FUEL INJECTOR**



## OPTI-FLOW™ LOW NO<sub>x</sub> FUEL INJECTOR

ABT has developed a reliable, high performance internally fuel staged low NO<sub>x</sub> fuel injector for installation on all types of boilers. ABT's segmented coal nozzle is used in several burner applications:

**Wall-Fired Burners:** Scroll or Elbow Inlet

**Tangential Fired Burners**

### THE OPTI-FLOW™ FUEL INJECTOR IMPROVES PERFORMANCE AND RELIABILITY BY

- Significantly decreasing NO<sub>x</sub>
- Eliminating coal layout and coking
- Eliminating excessive wear
- Reducing fuel injector pressure drop in scroll burner applications
- Minimizing fuel imbalance at the nozzle's exit (reduces NO<sub>x</sub> & UBC)

### A RANGE OF FLEXIBLE ALTERNATIVES ARE PROVIDED:

- Replace existing conventional low NO<sub>x</sub> fuel injectors with OPTI-FLOW™ design
- Convert turbulent burners to low NO<sub>x</sub> configuration while retaining the maximum amount of existing hardware
- Complete burner replacement where necessary

ABT utilizes a systems approach to analyze the problems and limitations of conventional low NO<sub>x</sub> fuel injectors. Primary tools: physical two-phase flow model and use of Computational Fluid Dynamics.

Our segmented coal nozzle tip, shown in Figure 1, is an internally staged design with an open cross section that continuously varies from a circular shape at the inlet to the multiple segment outlet.

Figure 1

Segmented coal nozzle tip

Coal is concentrated by aerodynamics, not by mechanical means, to form concentrated streams at the nozzle's exit. The streams form multiple flame patterns in the furnace.

There are no internal parts in the coal path, such as:

- Coal collecting ports or vanes
- Venturi collectors, diffusers or swirl generators
- Mixing "teeth" or internal stabilizers

Instead, our external stabilizers and axial vanes create a highly stable flame.

## IMPORTANCE OF FUEL DISTRIBUTION

Poor fuel distribution, leaving a low NO<sub>x</sub> coal nozzle, results in both NO<sub>x</sub> and Unburned Carbon being high.

Where fuel flow is excessively high, UBC will increase rapidly (excess O<sub>2</sub> too low).

Where fuel flow is excessively low, NO<sub>x</sub> will increase rapidly (excess O<sub>2</sub> too high).

Key to attaining low NO<sub>x</sub> with minimum unburned carbon (UBC), is minimizing the fuel imbalance leaving the coal nozzle. ABT has developed fuel distribution systems for both scroll and elbow inlets.

Our designs provide significant improvements in distribution leaving the segmented coal nozzle.

## SCROLL BURNERS:

Figure 2 illustrates the improvements attained by our OPTI-FLOW™ scroll distribution system. The standard open scroll produces fuel variations from 40% below to 60% above the norm.

### Scroll Burner NO<sub>x</sub> & LOI vs Fuel Distribution

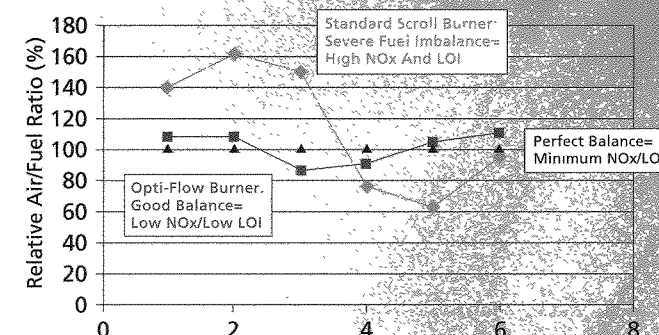


Figure 2

Fuel Distribution vs. NO<sub>x</sub> & UBC

Figure 3 illustrates the fuel injector system as developed for a scroll-inlet burner:



Figure 3

Fuel Injector

## SCROLL BURNER RESULTS

Table 1 compares relative data, obtained on a two-phase flow model for a standard scroll-inlet burner with the OPTI-FLOW™ design.

- Fuel distribution around the nozzle's outlet is improved by more than 3:1
- Total pressure drop is decreased by 60%
- Layout which causes coking is eliminated.

Table 1: Relative Data

Table 1: Relative Data			
Burner Type	Tip Dist. RMS (%)	DP, H <sub>2</sub> O	Layout
STD Scroll Inlet	3.17	2.5	Heavy
OPTI-FLOW™ Design	1.0	1.0	None

Figure 4 illustrates a successful conversion of a low NO<sub>x</sub> scroll burner, on a 700MW boiler, to ABT's OPTI-FLOW™ low NO<sub>x</sub> fuel injector.

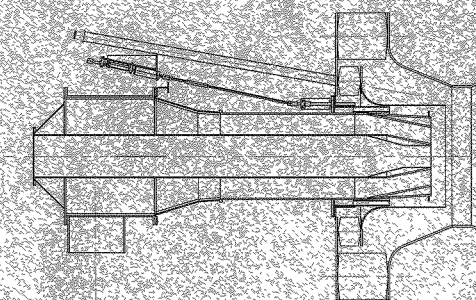


Figure 4

Drawing of ABT Conversion of OEM Low NO<sub>x</sub> Burner

Conversions of this type on bituminous coal fired boilers yield NO<sub>x</sub> levels of at least 30% below those of the original low NO<sub>x</sub> burner while maintaining unburned carbon in the same range as before. Greater NO<sub>x</sub> reductions have been attained with PRB.

## ELBOW-BASED FUEL INJECTORS

Advanced Burner Technologies has also developed a fuel distribution system that reduces the fuel imbalance that occurs in elbow-based fuel injectors by approximately 4.5:1. Figure 5 illustrates the results of our two-phase physical flow modeling with a standard 90° flatback elbow.

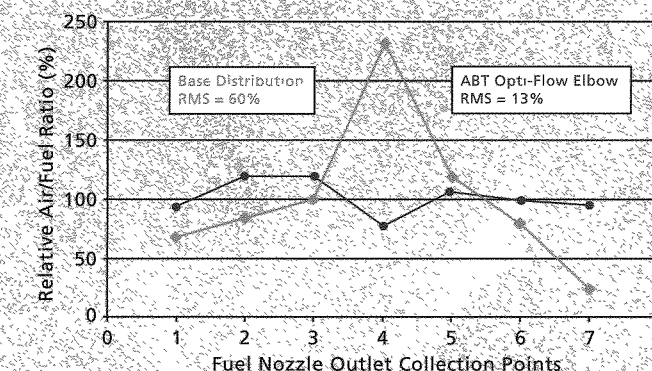


Figure 5

Elbow Fuel Distribution